

Television



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The elements of television system

TV definition

- TV system is an extension of science of radio communication with the additional complexity that besides sound the picture details are also to be transmitted.
- The picture signal is amplitude modulated and sound signal frequency modulated before transmission.

- The carrier frequencies are suitably spaced and the modulated outputs radiated through a common antenna.
- Thus each broadcasting station can have its own carrier frequency and the receiver can then be tuned to select any desired station.

Simplified block diagram of a monochrome television broadcasting system

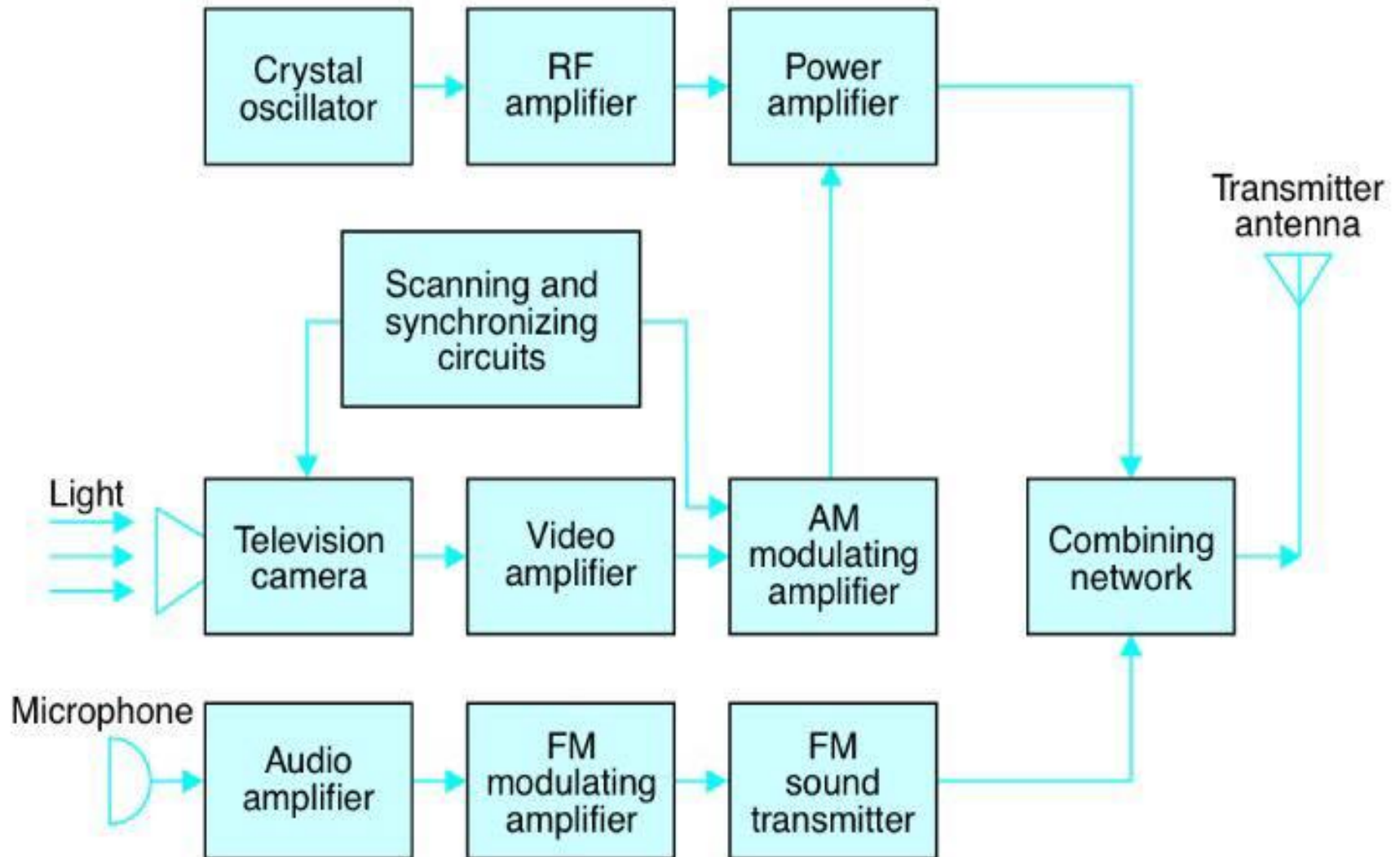
- The picture information is optical in character and may be thought of as an assemblage of a large number of bright and dark areas representing picture details.
- These elementary areas into which picture details may be broken up are known as 'picture elements', which when viewed together, represent the visual information of the scene.

- The information is a function of two variables, time and space.
- An infinite number of channels will be used to transmit optical information corresponding to all the picture elements simultaneously.
- Practical difficulties of transmitting all information simultaneously and decoding it at the receiving end seem insurmountable and so a method known as scanning is used instead.

- Conversion of optical information to electrical form and its transmission are carried out element by element, one at a time and in a sequential manner to cover the entire scene which is to be televised.
- Scanning of the elements is done at a very fast rate and this process is repeated a large number of times per second to create an illusion of simultaneous pick-up and transmission of picture details.

- A TV camera, the heart of which is a camera tube, is used to convert the optical information into a corresponding electrical signal, the amplitude of which varies in accordance with the variations of brightness.

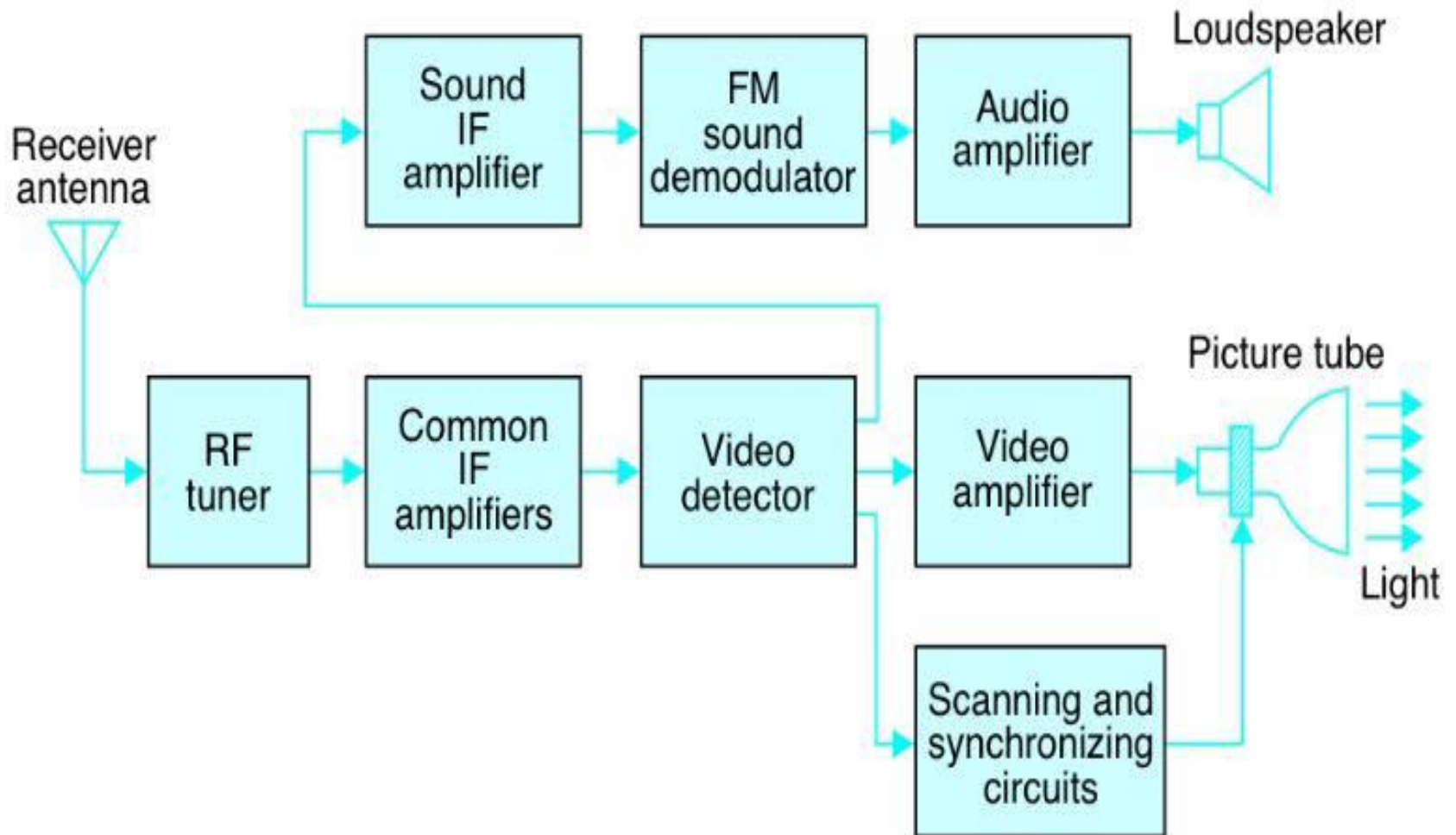
Basic monochrome television transmitter



- The microphone converts the sound associated with the picture being televised into proportionate electrical signal, which is normally a voltage.
- This electrical output, regardless of the complexity of its waveform, is a single valued function of time and so needs a single channel for its transmission.
- The audio signal from the microphone after amplification is frequency modulated, employing the assigned carrier frequency.

- In FM, the amplitude of the carrier signal is held constant, whereas its frequency is varied in accordance with amplitude variations of the modulating signal.
- output of the sound FM transmitter is finally combined with the AM picture transmitter output, through a combining network, and fed to a common antenna for radiation of energy in the form of electromagnetic waves.

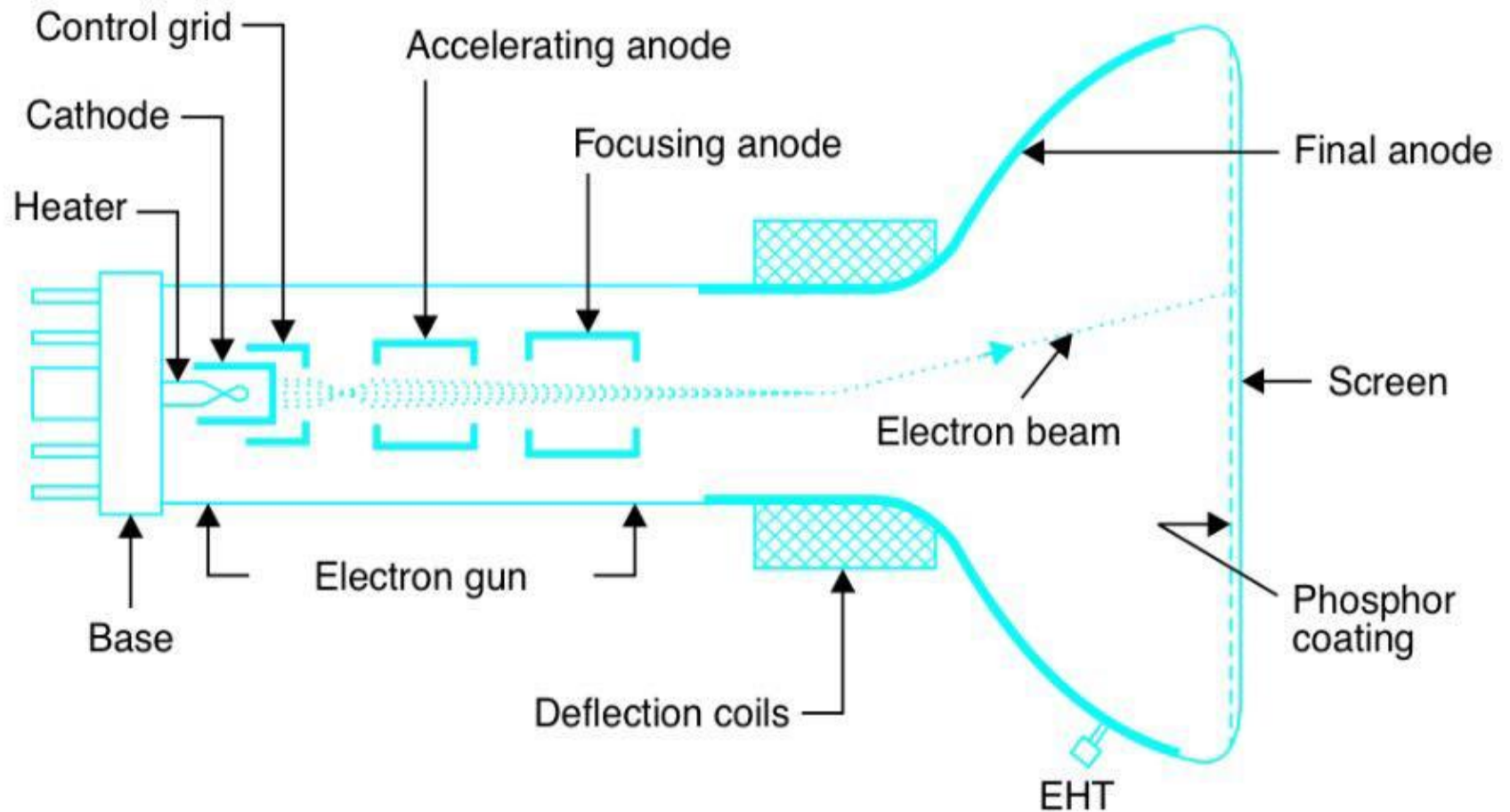
Basic monochrome television receiver



- The receiving antenna intercepts the radiated picture and sound carrier signals and feeds them to the RF tuner.
- The receiver is of heterodyne type and employs two or three stages of intermediate frequency (IF) amplification.
- The output from the last IF stage is demodulated to recover the video signal.

- This signal that carries picture information is amplified and coupled to the picture tube which converts the electrical signal back into picture elements of the same degree of black and white.

Elements of a picture tube



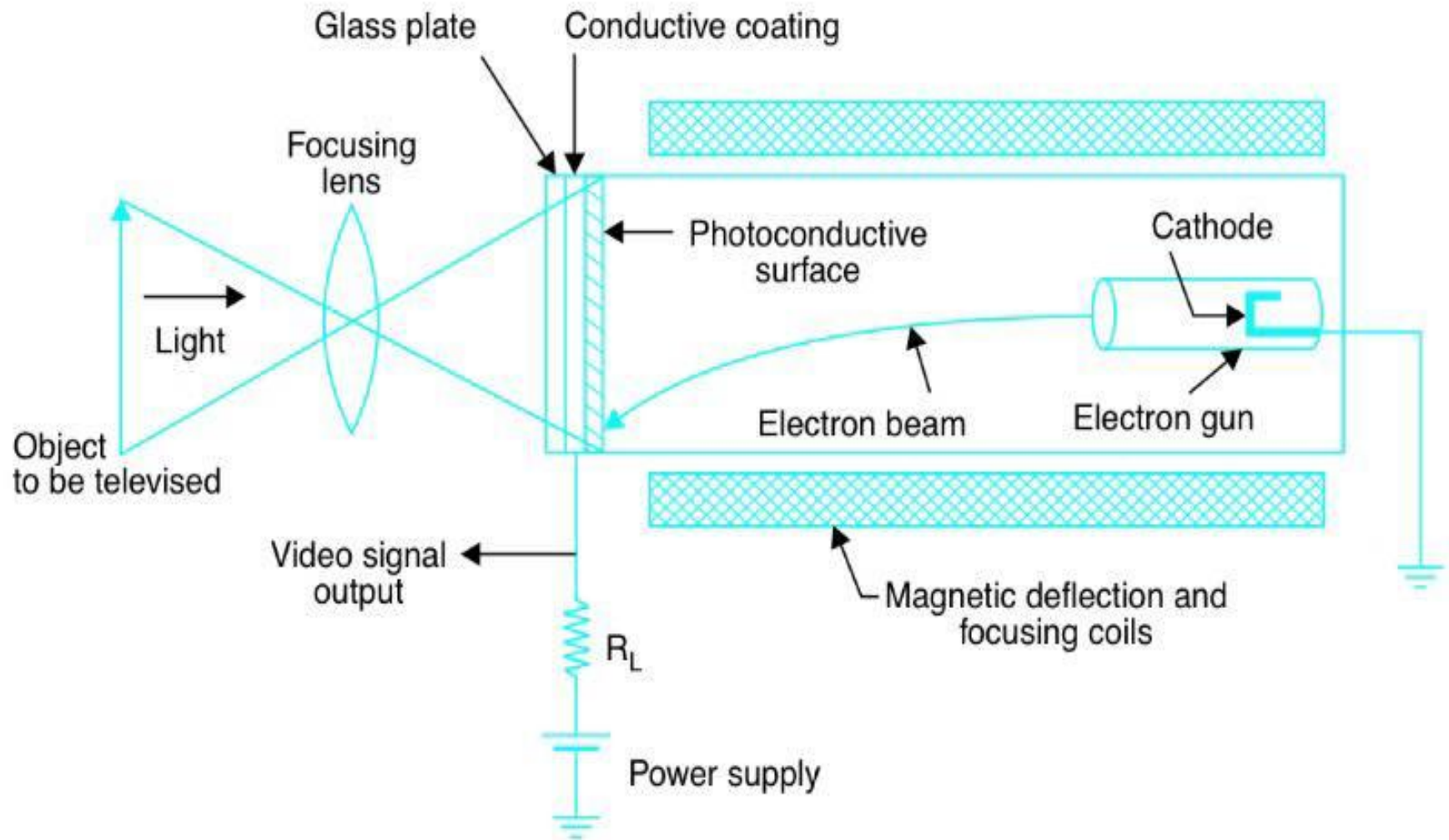
- The picture tube similar to the cathode-ray tube used in an oscilloscope.
- The glass envelope contains an electron gun structure that produces a beam of electrons aimed at the fluorescent screen.
- When the electron beam strikes the screen, light is emitted.

- The beam is deflected by a pair of deflecting coils mounted on the neck of the picture tube in the same way and rate as the beam scans the target in the camera tube.
- The amplitudes of the currents in the horizontal and vertical deflecting coils are so adjusted that the entire screen, called raster, gets illuminated because of the fast rate of scanning.

- The video signal is fed to the grid or cathode of the picture tube.
- When the varying signal voltage makes control grid less negative, beam current is increased, making spot of light on the screen brighter. More negative grid voltage reduces the brightness.
- if the grid voltages is negative enough to cut-off the electron beam current at the picture tube there will be no light. This state corresponds to black.

- Thus the video signal illuminates the fluorescent screen from white to black through various shades of grey depending on its amplitude at any instant.
- This corresponds to the brightness changes encountered by the electron beam of the camera tube while scanning the picture details element by element.
- The rate at which the spot of light moves is so fast that the eye is unable to follow it and so a complete picture is seen because of the storage capability of the human eye.

Simplified cross-sectional view of a Vidicon TV camera tube.

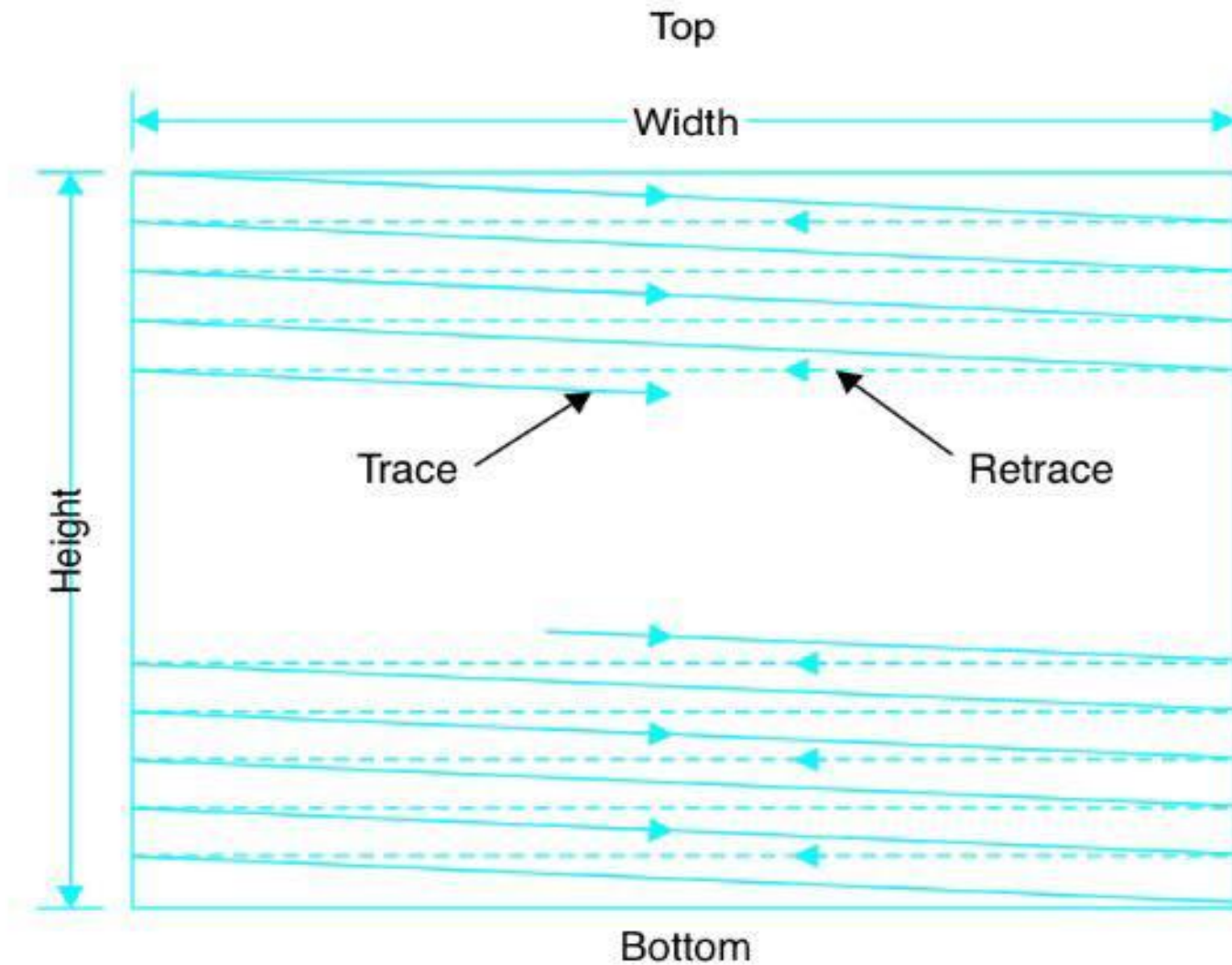


- A TV camera, the heart of which is a camera tube, is used to convert optical information into a corresponding electrical signal, the amplitude of which varies in accordance with the variations of brightness.
- An optical image of the scene to be transmitted is focused by a lens assembly on the rectangular glass face-plate of the camera tube.
- Inner side of the glass face-plate has a transparent conductive coating on which is laid a very thin layer of photoconductive material.

- The photo-layer has a very high resistance when no light falls on it, but decreases depending on the intensity of light falling on it.
- Thus depending on the light intensity variations in focused optical image, the conductivity of each element of the photo-layer changes accordingly.
- An electron beam is used to pick-up picture information now available on the target plate in terms of varying resistance at each point.

- The beam is formed by an electron gun in TV camera tube.
- On its way to the inner side of glass faceplate it is deflected by a pair of deflecting coils mounted on glass envelope and kept mutually perpendicular to each other to achieve scanning of the entire target area.
- Scanning is done in the same way as one reads a written page to cover all the words in one line and all the lines on the page.

Path of scanning beam in covering picture area



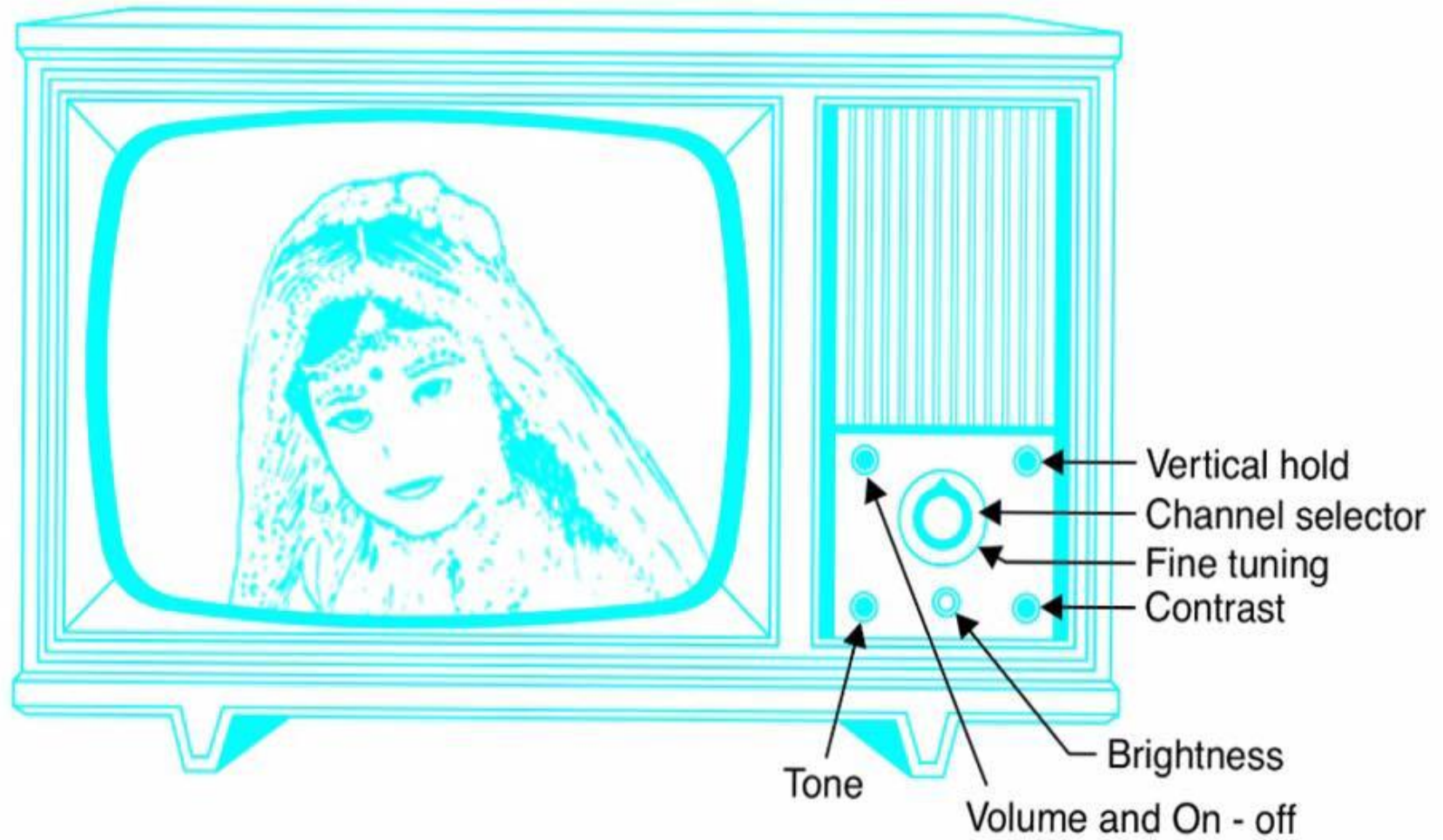
- Scanning is done in the same way as one reads a written page to cover all the words in one line and all the lines on the page.
- To achieve this the deflecting coils are fed separately from two sweep oscillators which continuously generate saw-tooth waveforms, each operating at a different desired frequency.
- The magnetic deflection caused by the current in one coil gives horizontal motion to the beam from left to right at a uniform rate and then brings it quickly to the left side to commence the trace of next line.

- The other coil is used to deflect beam from top to bottom at a uniform rate and for its quick retrace back to the top of the plate to start this process all over again.
- Two simultaneous motions are thus given to the beam, one from left to right across the target plate and the other from top to bottom thereby covering the entire area on which the electrical image of the picture is available.
- As the beam moves from element to element, it encounters a different resistance across the target-plate, depending on the resistance of the photoconductive coating.

- The result is a flow of current which varies in magnitude as the elements are scanned. This current passes through a load resistance R_L , connected to the conductive coating on one side and to a dc supply source on the other.
- Depending on the magnitude of the current a varying voltage appears across the resistance R_L and this corresponds to the optical information of the picture.
- If the scanning beam moves at such a rate that any portion of the scene content does not have time to move perceptibly in the time required for one complete scan of the image, the resultant electrical signal contains the true information existing in the picture during the time of the scan.

- The desired information is now in the form of a signal varying with time and scanning may thus be identified as a particular process which permits the conversion of information existing in space and time coordinates into time variations only.
- The electrical information obtained from the TV camera tube is generally referred to as video signal.
- This signal is amplified and then amplitude modulated with the channel picture carrier frequency. The modulated output is fed to the transmitter antenna for radiation along with the sound signal.

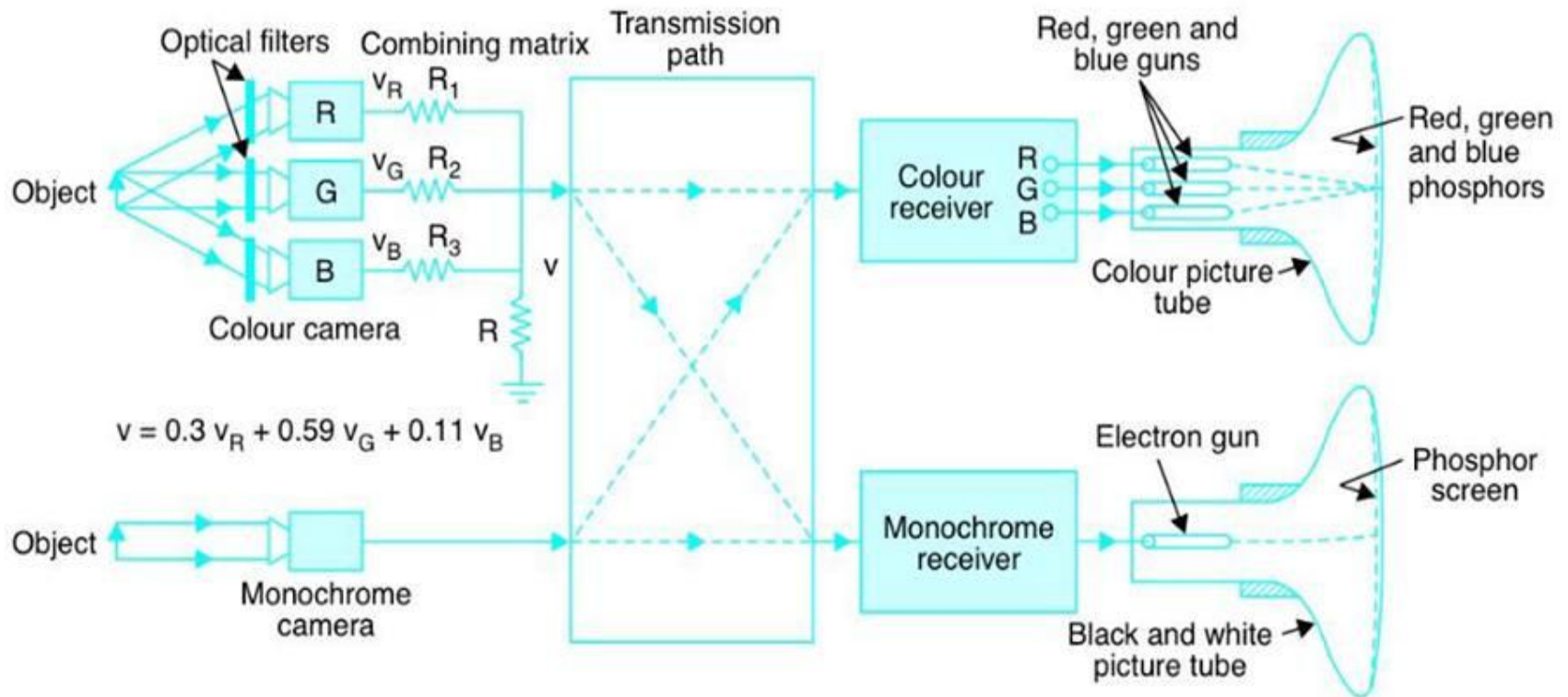
Television receiver controls



- The channel selector switch is used for selecting the desired channel.
- The fine tuning control is provided for obtaining best picture details in the selected channel.
- The hold control is used to get a steady picture in case it rolls up or down.
- The brightness control varies the beam intensity of the picture tube and is set for optimum average brightness of the picture.

- The contrast control is actually the gain control of video amplifier. This can be varied to obtain desired contrast between the white and black contents of the reproduced picture.
- The volume and tone controls form part of the audio amplifier in the sound section, and are used for setting the volume and tonal quality of the sound output from the loudspeaker.

Signal transmission paths



- R, G and B represent three camera tubes which develop video signals corresponding to red, green and blue contents of the scene being televised.
- NTSC colour television receivers have two additional controls, known as Colour and Hue controls. These are provided at the front panel along with other controls.
- The colour or saturation control varies the intensity or amount of colour in the reproduced picture.

- The tint or hue control selects the correct colour to be displayed. This is primarily used to set the correct skin colour, since when flesh tones are correct, all other colours are correctly reproduced.

Review Questions

1. Why is scanning necessary in TV transmission ? Why is it carried out at a fast rate ?
2. What is the basic principle of operation of a television camera tube ?
3. What is a raster and how is it produced on picture tube screen ?
4. Why are synchronizing pulses transmitted along with the picture signal ?

5. Why is FM preferred to AM for sound signal transmission ?
6. Describe briefly the functions of various controls provided on the front panel of a TV receiver.
7. Describe the basic principle of colour television transmission and reception.
8. Describe function of saturation and hue controls in a NTSC colour TV receiver.

Any Questions

